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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/026,378	12/21/2001	Jing-Pei Chou	000761/P11	8194

32588 7590 05/11/2004

APPLIED MATERIALS, INC.
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EXAMINER	
PADGETT, MARIANNE L	

ART UNIT	PAPER NUMBER
1762	

DATE MAILED: 05/11/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/026,378	CHOU ET AL.	
	Examin r	Art Unit	
	Marianne L. Padgett	1762	

-- The MAILING DATE of this communication appears on the cov r sheet with the correspondenc address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *15 March 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,3,4,6-9,11-15,17-26,28,29,31-34,36-45,47-51,53-67 and 69-73* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,3-4,6-9,11-15,17-26,28-29,31-34,36-45,47-51,53-67,69-73* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *17 June 2002* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 3/15/04 has been entered.

2. As noted in the advisory action of mailed 3/4/04, the 112 rejections have been over come. While it is not necessary under present PTO 112 policies, as subsections of claims refer to nomenclature, such as "step(c)" in line 10 of claim 15, or "step (d)" in lines 8 or 9 of claims 1 or 26, etc, it would be appropriate for clarity to actually define (a), (b), etc., as steps via use of consistent nomenclature by inserting --steps of-- after "comprising" in the preambles of independent claims.

Applicants have amended their claims, such that independent claims 1 and 26, now both require $TiCl_4 + NH_3$ to deposit TiN, and a subsequent H-plasma treatment, hence Yi et al (WO 00/16377), is no longer a 102 reference thereover, because while it may employ either Ar or H_2 between reaction steps, it does not use plasma in any of its "non-reactive" gas flows. It is noted that while the exemplary metal is an organotitanium compound, p.5 indicates that Ti, Ta or W may be used in the forms of organometallic or halogenated metal compounds as reactants, so use of $TiCl_4$ is obvious as suggested, but the H-plasma has no suggestion in Yi et al.

Levine et al (5,989, 999), is also removed as a 102 reference by the amendment, because although they teach post TiN deposit plasma treatment that may use hydrogen, the deposition

precursors are exclusively organometallics, where the post deposition plasma annealing is removing residual carbon, which will also reduce O-absorption, thus improving film stability.

It is noted that Min et al was cited as having some teachings analogous to Yi et al, and it was NEVER applied in any rejection, so no rejection over Min et al can be withdrawn, but the amendments' exclusion of it analogous to Yi et al is noted.

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

4. Claims 15, 17-18, 20-25, 40, 42-45, 47-51, 52-54, 56-62 and 64-73 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lu (6,017,818), in view of Sivaram (Chem. Vap. Dep: thermal & Plasma Dep. of Electronic Mat.), as discussed in section 3 of paper #6, (mailed 4/14/03) and paper # 9 (mailed 11/15/03); and further in view of Levine et al (section 7, paper # 9, mailed 11/15/03, and section 2 above), or Kim et al (GB 2,299,345A) or Sandhu (5,576,071) as applied in section 4 of paper #6 and section 4 of paper #9.

As presently amended, none of the claims in this rejection specify how the TiN was deposited, but all of them require the deposited titanium nitride film to be treated with H-plasma, which as previously noted is not taught by Lu, but is taught by all the ternary references, who are all employing organometallic precursors analogous to those used in Lu, where Kim et al teach that plasma treatment with N_2+H_2 dissociate the C and O atoms bonded in the TiN layer, so lower resistivity that may be maintained over time is achieved (p.2-4); Sandhu teach H-plasma removes contaminating hydrocarbons in the deposit, as well as teaching purging, again teaching the advantages to resistance and lower oxide formation; and Levine et al, like the previously combined ternary references, teaches the plasma treatment, that may use NH_3, removes carbon which impairs the stability of the film and adversely effects the resistance when exposed to air. Levine et al is a new combination with Lu plus Sivaram, and some of the claims are newly added to this grouping due to the amendments, but the combination now inclusive of Levine as an alternative still applies. Restated, it would have been obvious to one of ordinary skill in the art that the use of H-plasma in the process of Lu as combined with Sivaram, would have been obvious for the advantages of improved film quality, stability and resistance values, due to reduced C and resultant O contamination achieved by the H-plasma processing.

5. Claims 1, 3-4, 6-9, 11-15, 17-26, 28-29, 31-34, 36-45, 47-51, 53-67 and 69-73 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lu in view of Sivaram as applied in sections 3 of papers #6 and 9, and further in view of Foster et al (5,567,483) as applied in sections 4 of papers #6 and 9.

As amended some of these claims, particularly independent claims 1 and 26, as well as dependent claims 19, 41, 55, 63 require the use of $TiCl_4$ + NH_3 to produce the TiN film. As

previously noted, Lu teach that CVD using these gases has been utilized, but had the problem of Cl incorporation in the deposits, but as previously noted Foster et al teach plasma annealing where NH_3 containing plasma is preferred, and results in significantly lower Cl contents and resistivity than when thermal annealing is used to reduce [Cl]. Therefore, it would have been obvious to one of ordinary skill in the art that Foster et al's technique addresses the concerns expressed in the background of Lu et al for the use of $TiCl_4$+NH_3, hence use of these inorganic precursors, with the NH_3-plasma post TiN deposition treatment, would have been an obvious alternative deposition technique to use of TDMAT in the process of Lu for forming Ti-Si-N films, because it demonstrates equivalent effectiveness for like purposes, with the desired advantage of low resistivities.

6. Applicant's arguments with respect to claims 1, 3-4, 6-9, 11-15, 17-26, 28-29, 31-34, 36-45, 47-51, 53-67 and 69-73 have been considered but are moot in view of the new ground(s) of rejection.

Applicant's arguments filed 3/15/04 and 2/3/04, and discussed above have been fully considered but they are not persuasive.

Further comments concerning removal of by-products and purge gases: the references need not explicitly discuss such removal for it to occur, especially as gas flow as described by Sivaram et al inherently removes by products. Thus, their removal is expected for CVD reactions in general, especially as it is known for various TiN deposits that by-products typically contain contaminates, which if allowed to build up would contaminate deposits, producing inferior films, so the continuous gas flow of CVD processes is old, well known and standardly used for by-product and unused precursor removal. Also, as shown previously and above, the

reactions are known to produce undesirable by-products or contaminates, i.e. halogens or carbon, as shown by Levine et al, Kim et al, Sandhu (071) or Foster et al, thus providing extra incentive and motivation for one of ordinary skill and competence to ensure and maximize by-product removal to the extent practical by such conventional techniques. Purge gases may be considered a standard technique for optimizing removal of undesirable reaction by-products.

7. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. See *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970);and, *In re Thorington,* 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.130(b).

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

8. Claims 15, 17-18 & 20-25 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-7 and 10 of U.S. Patent No. 6,699,530 B2 in view of Sandhu (071).

The independent claim 1 of the patent differs from the instant claims by being to the broader limitation of metal nitride, but as this limitation totally encompasses the TiN of the present claims, this reads on TiN and is an obvious variation. The patent also requires adding a capping layer to the Si treated metal nitride deposit, whereas this applications claims only require the deposition and treatment by various gas flows/plasmas, however Sandhu (previously discussed) who deposits analogous TiN deposits teach that sublayers of TiN deposits may be desirable for effective treatment to modify the full depth of desired layer thickness, where the top

layer may be considered to read on a capping layer. See figures 1-4 and col.4, lines 49-col.5, line 20. Therefore, it would have been obvious to one of ordinary skill in the art that the layer deposition of TiN with its subsequent treatment could have advantageously been preformed repeatedly, for reasons as provided by Sandhu, where the last deposited sublayer may be called a "capping layer."

Other limitations are claimed indifferent orders and overlapping scopes, but constitute obvious variations in the deposition of Ti-Si-N or more generally metal-Si-N materials.

9. Claims 1, 3, 4, 6-9, 11-15, 17-26, 28-29, 31-34 and 36-45, 47-51, 53-67 and 69-73 are provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-40 of copending Application No. 10/124,575 in view of Lu (discussed above and in previous cited actions.

The copending applications of 10/124,575 has steps as claimed in the present case, with some variation in order claimed and scope, but overlapping and encompassed by the present claims, except the copending case also requires that the substrate (of unspecified material) first be exposed to a Si-containing gas for unstated effect. Also the copending case does not claim movement to another chamber for subsequent treatment steps of the deposited TiN layer. However, Lu et al discussed previously teaches the possible performance of treating steps in the same or different chamber from deposition (col.4, lines 1-17), hence movement as claimed would have been obvious as a known procedure for like deposition and treatment sequences, and motivated by standard reasons associated with manufacturing/economic requirements for scale of the production line, and required or desired thru-put on a production line.

With respect to initial exposure to Si-containing gas, the present claims are generic as to the substrate, with some claims requiring an intended use, of the TiSiN as a barrier layer, hence any substrates which are composite materials, where a layer was deposited using Si-containing gas, as is common in semiconductor processing, would have been obvious to one of ordinary skill in the art to employ. Such an example is supplied by Lu who discloses the fabrication of TiN modified to TiSiN layers to be used as barrier layers on substrates that have had dielectric layers deposited thereon, where the dielectric layer may include TEOS deposited SiO_2 (col.3, lines 30-40; and col.6, line 60-col.7, line 30), thus providing an example consistent with copending application requirements of the type of substrate with previous exposure to Si, that one of ordinary skill in the art would have found obvious or typical to employ for the present claims process.

This is a provisional obviousness-type double patenting rejection.

10. As noted in copending 10/124,575, section 3 of paper #20031213, Shue et al (6,271,136 B1) may be considered equivalently with Lu for the purposes of obvious double patenting.

11. Other related cases of interest include Wang et al (6,555,183 B2) and (6,548,402 B2), which have TiN deposition from claimed material with claimed subsequent H-plasma treatment, but have further deposition and plasma parameters and/or microstructure not required by the present claims, nor is the TiN deposit then converted to Ti-Si-N, although Si-electrodes may be deposited on the TiN. Copending Patent 6,436,820 to Hu et al contains similarly related claim limitations to Wang et al.

The Chang et al (6,432,479 B2) patent has TiN formation and plasma treatment, without the subsequent processing when using TiN deposition semiconducting device manufacture, but turns Ti into TiN instead of initially depositing the nitride. Also, the Chang et al patent uses alternative language from the present case, but the concepts preformed in their limitation steps are analogous with those presently claimed, i.e. while Chang requires H and N to be flowed without plasma, when the present case may use one or more purge gases, such as N_2 or H_2, then both may employ plasma.

Tseng et al (6,291,343 B1), who has overlapping inventors and is within a year of applicants' filing date has broad process claims to depositing a metal nitride, then exposing to plasma (1b) + 1c)), but also requires some sort of plasma processing to precede the nitride deposition. Zhang et al to the same assignee, but different inventors has TiN formation from $TiCl_4$+NH_3 with subsequent NH_3-plasma treatment, but lacks the other steps.

Arkles et al (2002/0197403 A1) and Akram (6,696,109 B2) are of interest for Ti-Si-N deposition, but deposit the Si with the Ti and N, not in a subsequent step.

12. Claims 15, 17, 18, 20-22 and 24-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Chen et al (6,562715) in view of Sivaram.

It is noted that while Chen et al is to the same assignee, there are no overlapping inventors, and the 8/9/00 filing date predates applicant's 12/21/01 date.

Chen et al has teachings equivalent to Lu on col.8, lines 23-54 for Ti-Si-N deposition, but also performs plasma (N_2+H_2) post TiN deposition before exposing the TiN to Si-containing gas like silane. Chen et al does not discuss purging after deposition and plasma steps, however above discussions concerning purging, as also supported by Sivaram as previously discussed in

section 3 of paper # 6 mailed 4/14/03 and paper # 9 mailed 11/15/03, are applicable for reasoning as previously stated.

Particular time parameters for post-treatments would have been dependant of particular preceding TiN deposition parameters, and determined by routine experimentation for desired quality or characteristics, and use of inert gases, or H_2 or N_2 already employed by Chen et al, as plasma gases or carrier gases or purge gases is a conventional technique, hence would have been an obvious and/or expected procedure for performing the taught deposition, due to either their lack of reactivity or their compatibility with the preceding deposits or the operations being preformed.

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Marianne Padgett whose telephone number is (571) 272-1425. The examiner can normally be reached on M-F from about 8:30a.m to 4:30p.m.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Beck Shrive, can be reached on 571-272-1415. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Padgett/tgd 4/26/2004 & 5/10/2004

MARIANNE PADGETT
PRIMARY EXAMINER